

MOBILE COMPUTING

CSE-4225



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Course Goals

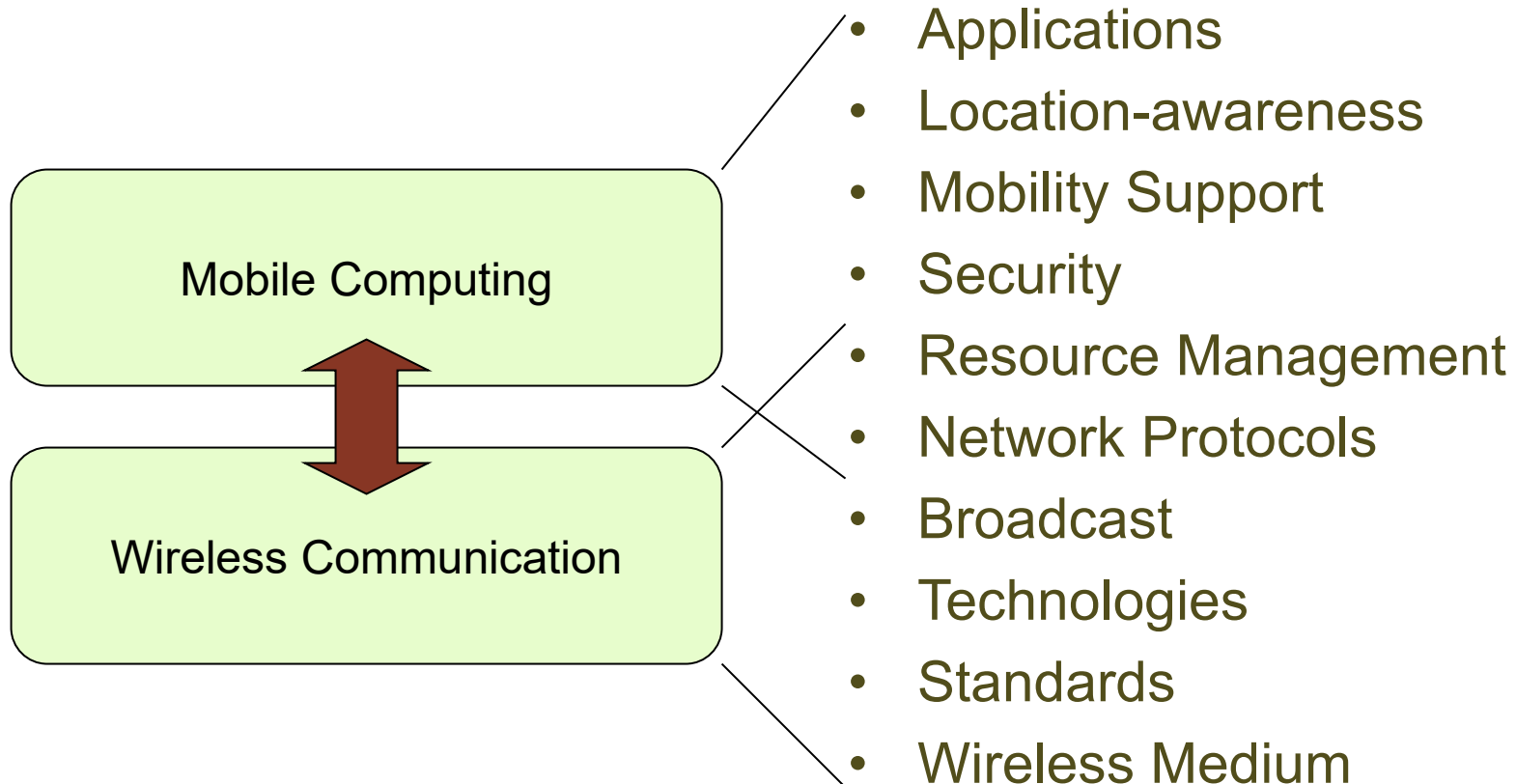
- Fundamentals of mobile computing
- Fundamentals of wireless networking
- Topics from closely related areas:
 - Pervasive Computing
 - Wearables
 - Internet of Things
 - Real-Time Systems
 - Embedded Systems
 - Wireless sensor networks
- Acquire and practice development skills

Mobile Computing (MC)



- Umbrella term used to describe technologies that enable people to access services **anytime** and **anywhere**
- Allows transmission of **data, voice and video** via a **computer or any other wireless enabled device** without having to be connected to a fixed physical link
- Main concept involves
 - Mobile Communication
 - Mobile Hardware
 - Mobile Software

Mobile Computing



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Wired vs Wireless

• **Wired Networks**

- high bandwidth
- low bandwidth variability
- can listen on wire
- high power machines
- high resource machines
- need physical access (security)
- low delay
- connected operation

• **Mobile Networks**

- low bandwidth
- high bandwidth variability
- hidden terminal problem
- low power machines
- low resource machines
- need proximity
- higher delay
- disconnected operation

Main Concept: Mobile Comm.

- Refers infrastructure to ensure seamless and reliable communication
- Protocols, services, bandwidth, and portals
- No collision with other existing systems (as well as same service)

Main Concept: Mobile H/W

- Includes mobile devices or device components that receive or access the service of mobility
- Capable of sensing and receiving signals
- Capable of sending and receiving signals at the same time
 - Which transmission mode?
- Example
 - portable laptops, smartphones, tablet PCs, Personal Digital Assistants

Main Concept: Mobile S/W



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Mobile Computing: Aspects

- **User Mobility**

- Users communicate “anytime, anywhere, with anyone”
- Example: read/write email on web browser

- **Device Portability**

- Can be connected anytime, anywhere to the network (using different mechanisms)

- **Communication Device Characteristics**

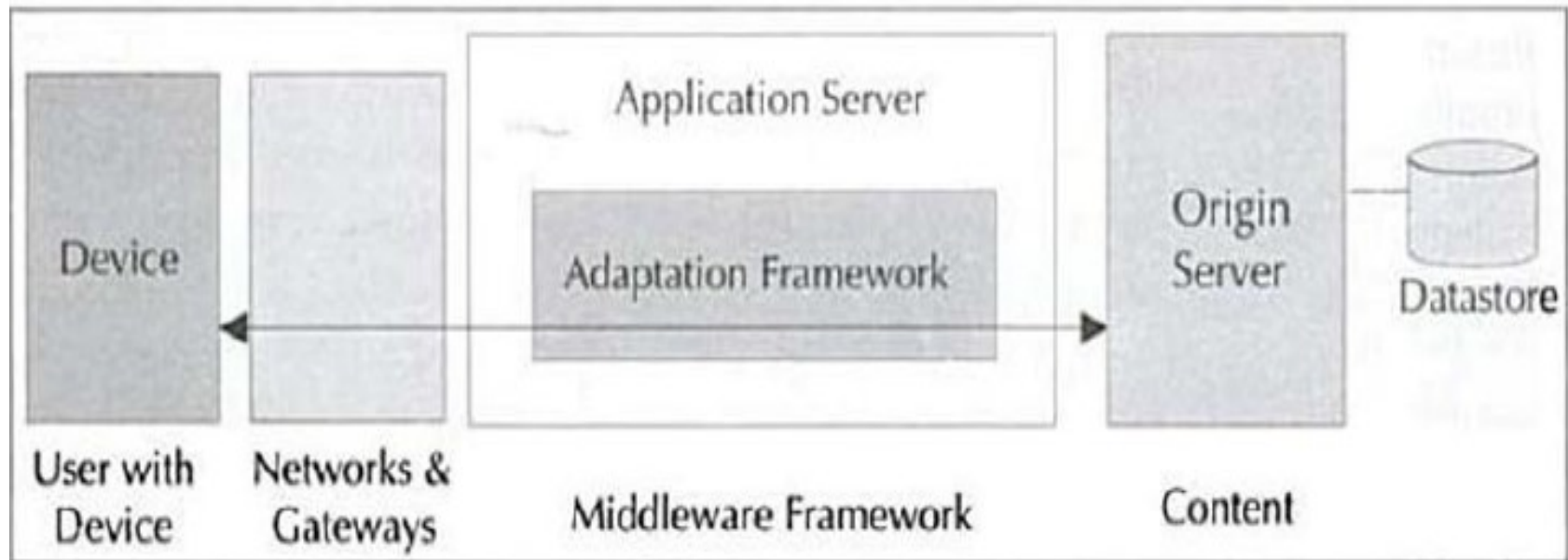
- Fixed and wired
- Mobile and wired
- Fixed and wireless
- Mobile and wireless (most interesting)
 - Most successful: GSM with more than 800 million users

Mobile Computing: Functions

- **User Mobility**
- **Device Mobility**
- **Network Mobility**
 - Able to move from one network to another network (can be another country)
- **Bearer Mobility**
 - Allows a device to change bearers (WLAN, 3G, GPRS) without interruption to the user's data sessions
- **Session Mobility**
 - Able to move from one user-agent (acting on behalf of a user, such as a web browser) environment to another
- **Service Mobility**
 - Able to move from one service to another
- **Host Mobility**
 - Either a client or server

Logical Functions of MC

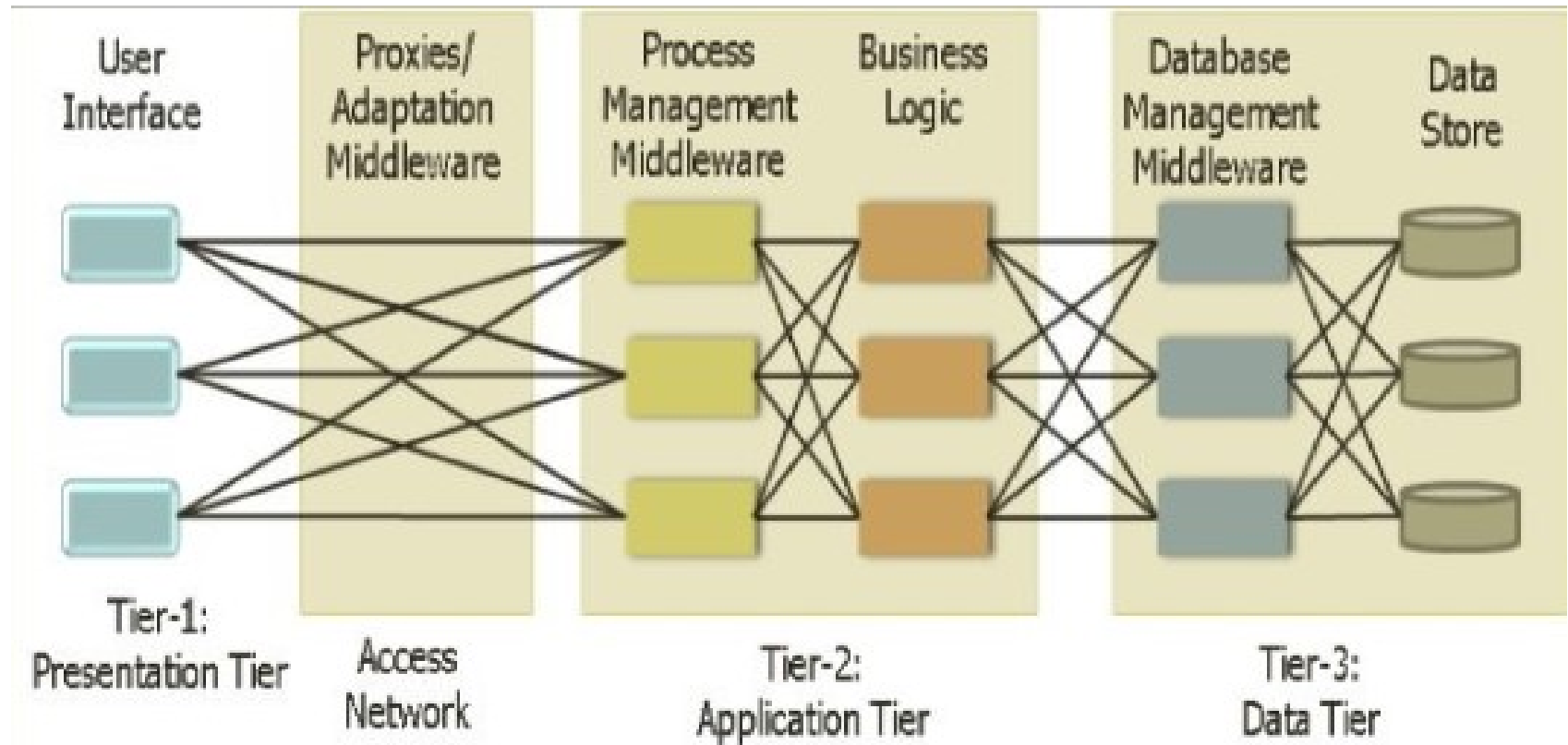
- **User with device**
- **Network**
- **Gateways**
- **Middleware**
- **Contents**



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Mobile Computing: Architecture



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Mobile Computing: Architecture

- **Presentation Layer (UI)**

- Presents data to the user
- Permits data manipulation and data entry
- Requests the data form Business layer
- Accomplished through use of Dynamic HTML and client-side data sources and data cursors

Mobile Computing: Architecture

- **Business Logic Layer**

- Acts as the server for client requests from workstations according to Business rules fetch or insert data through the Data Layer
- Determines what data is needed (and where it is located) and acts as a client in relation to a third tier of programming that might be located on a local or mainframe computer
- As not tied to a specific client, it can be used by all applications and can be moved to different locations, as response time and other rules require

Mobile Computing: Architecture

- **Data Access Layer**

- Made up of the DBMS that provides all the data for the above two layers.
- Avoiding dependencies on the storage mechanisms
 - Allows for **updates or changes** without the application tier clients being affected by or even aware of the change

Mobile Computing: Applications

- **Vehicles**
- **Emergencies**
- **Business**
- **Credit Card Verification**
- **Infotainment**
 - Broadcast material that is intended both to entertain and to inform
- **Where not?**

Mobile Computing: Limitations

- Resource constraints: Battery
- Interference
- Bandwidth
- Dynamic changes in communication environment
- Network Issues
- Interoperability issues
 - varying protocol standards
- Security constraints

Example: Smartphone

- **Portability:** carry it anywhere you want
- **Miniaturization:** make it possible to build device to fit in your pocket
- **Connectivity:** Wi-Fi, LTE/4G, cellular, Bluetooth
- **Convergence:** phone, camera, gaming device, movie streaming, music player, ...
- **Divergence:** ?
- **Applications:** “Rise of the Apps”
- **Digital Ecosystem:** social networks, distributed gaming, video streaming, work apps, ...

App Store (iOS)

- 2003: iTunes Music Store
- 2008: iPhone App Store (iPhone 3G with App Store support)
- 2015: > 100 billion app downloads
- 2016: > 2 million apps
- 2016: China biggest App Store market
- 2016: App developers earned \$20 billions
- Most downloaded app: Minecraft Pocket Edition (paid) and Pokemon GO (free)

Trends in Mobile: Phone Subscribers



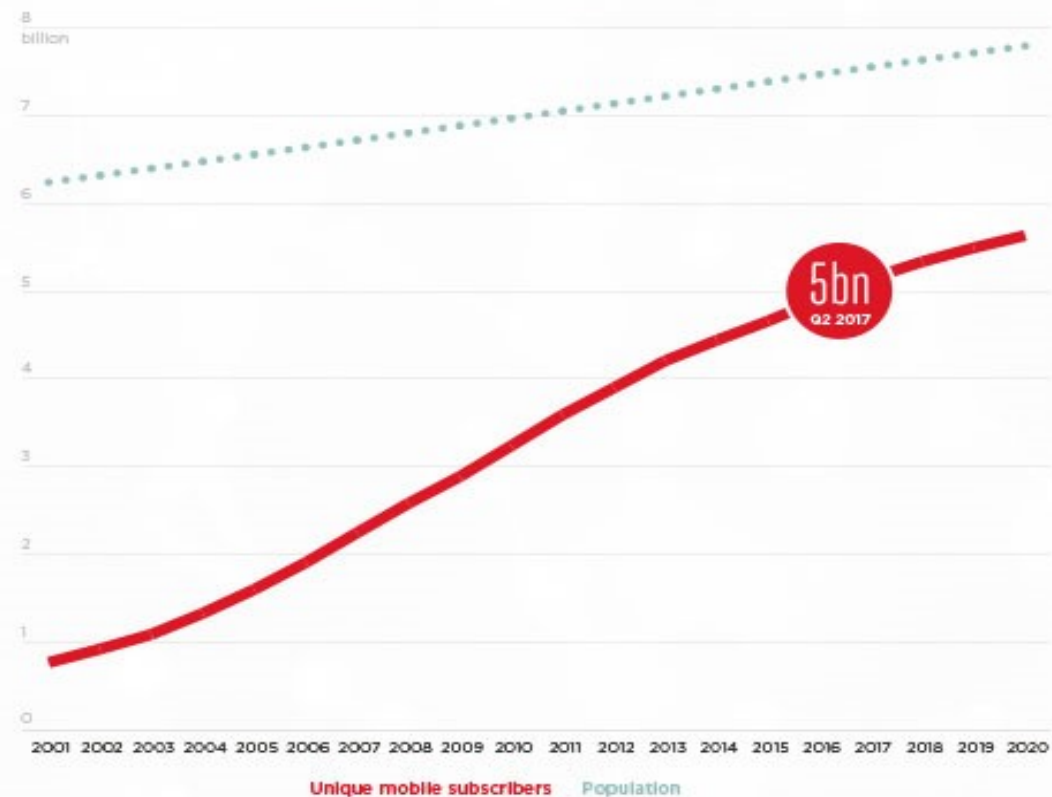
Key takeaways 4

1 5 billion people now use mobile – the highest scale consumer tech worldwide

Two thirds of the global population are now mobile subscribers; mobile has a greater reach than any other technology.

However, the rate of growth is slowing. It took four years to move from 4 billion to 5 billion; reaching 6 billion will take longer still.

EVOLUTION OF MOBILE SUBSCRIBER PENETRATION



Source: GSMA Intelligence

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Trends in Mobile: Shopping



In stores, **82% of smartphone users** turn to their devices to help them **make a product decision.**

SOURCE: Google/Ipsos, "Consumers in the Micro-Moment" study, March 2015, United States. ThinkwithGoogle.com

91% growth in B2B researchers using smartphones throughout the path to purchase



Inspiration



Research



Purchase



Post Purchase

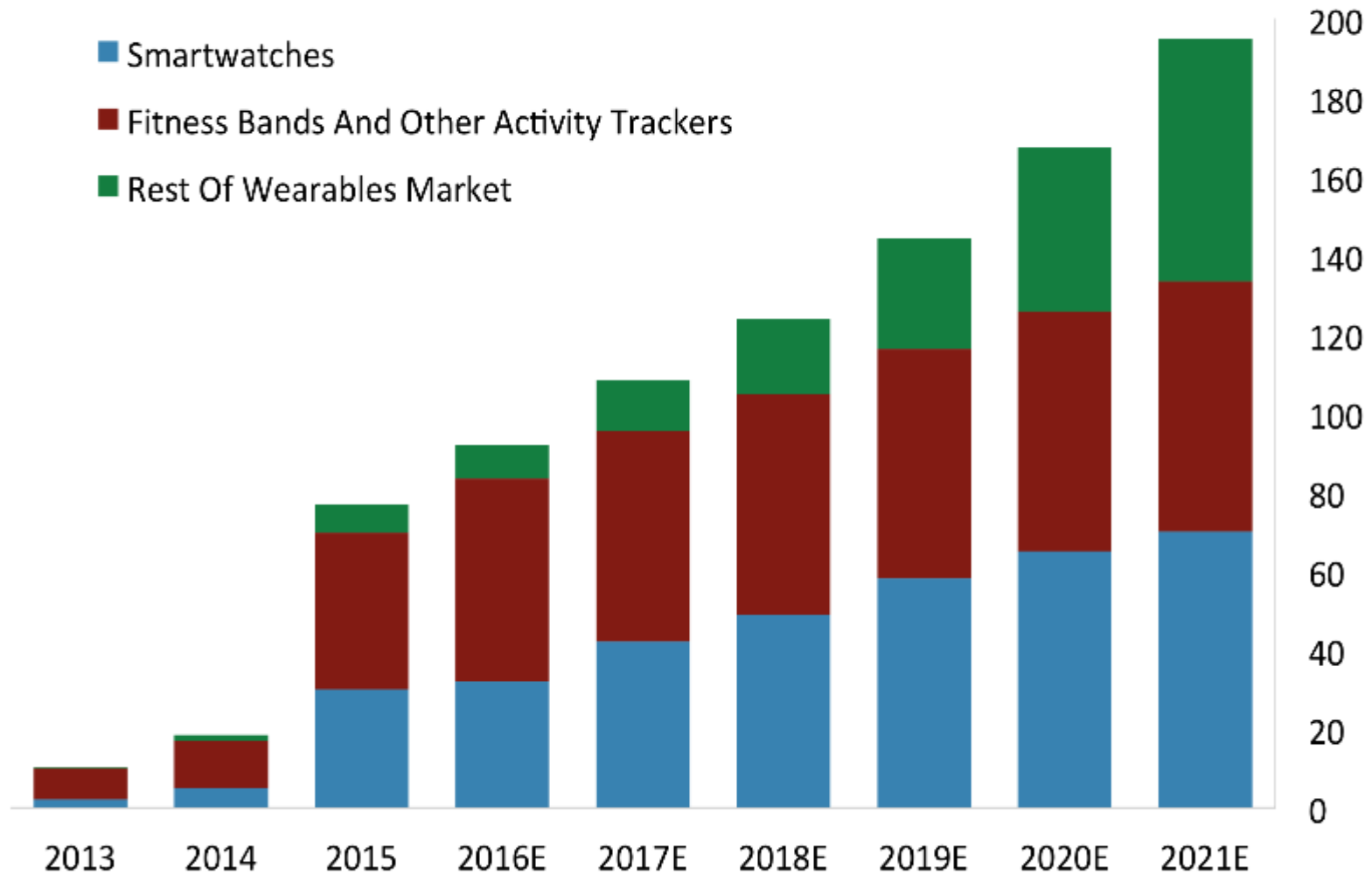
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Global Wearables Shipment Forecast, By Device

Millions

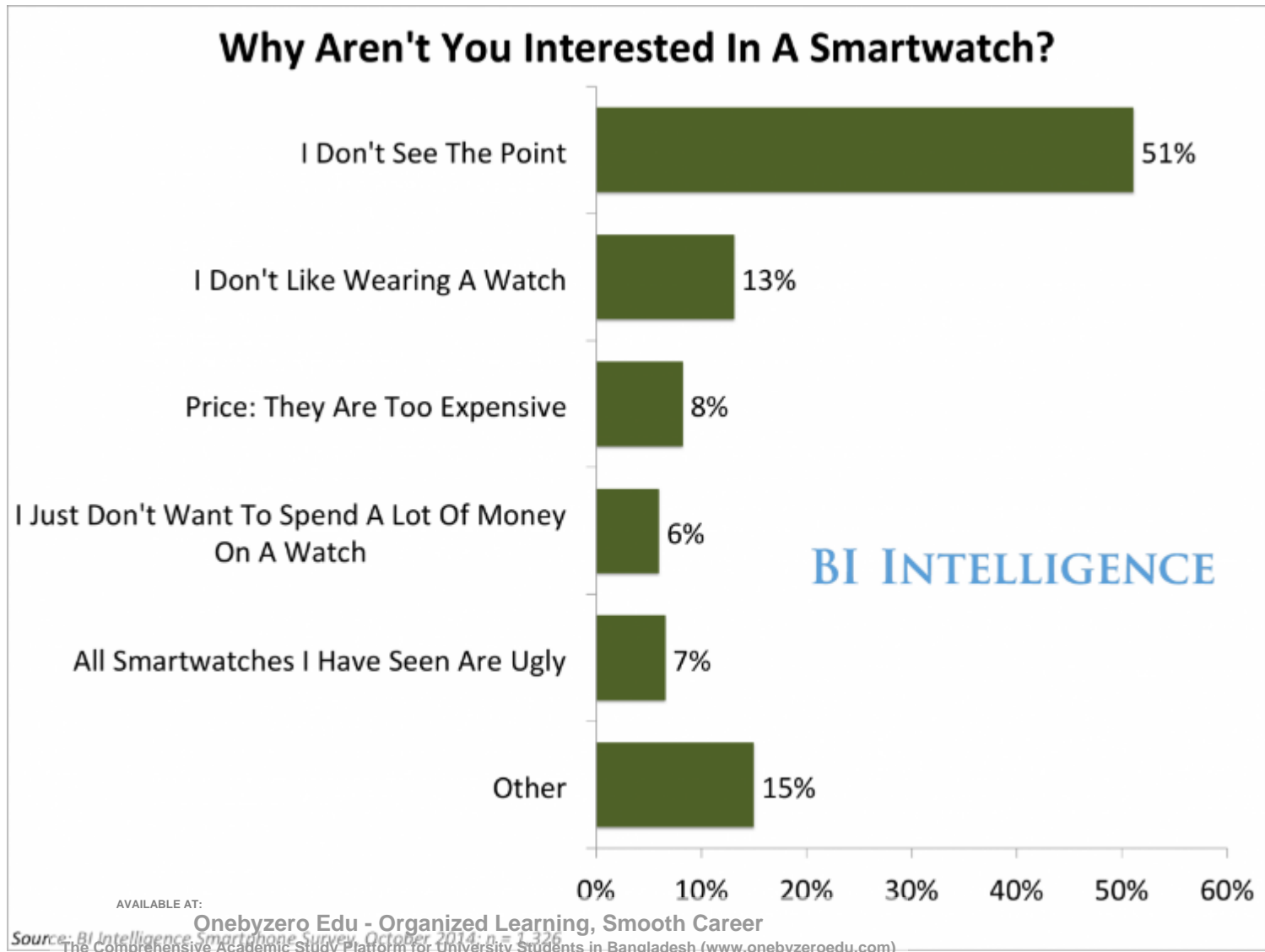


Source: IDC, BI Intelligence estimates
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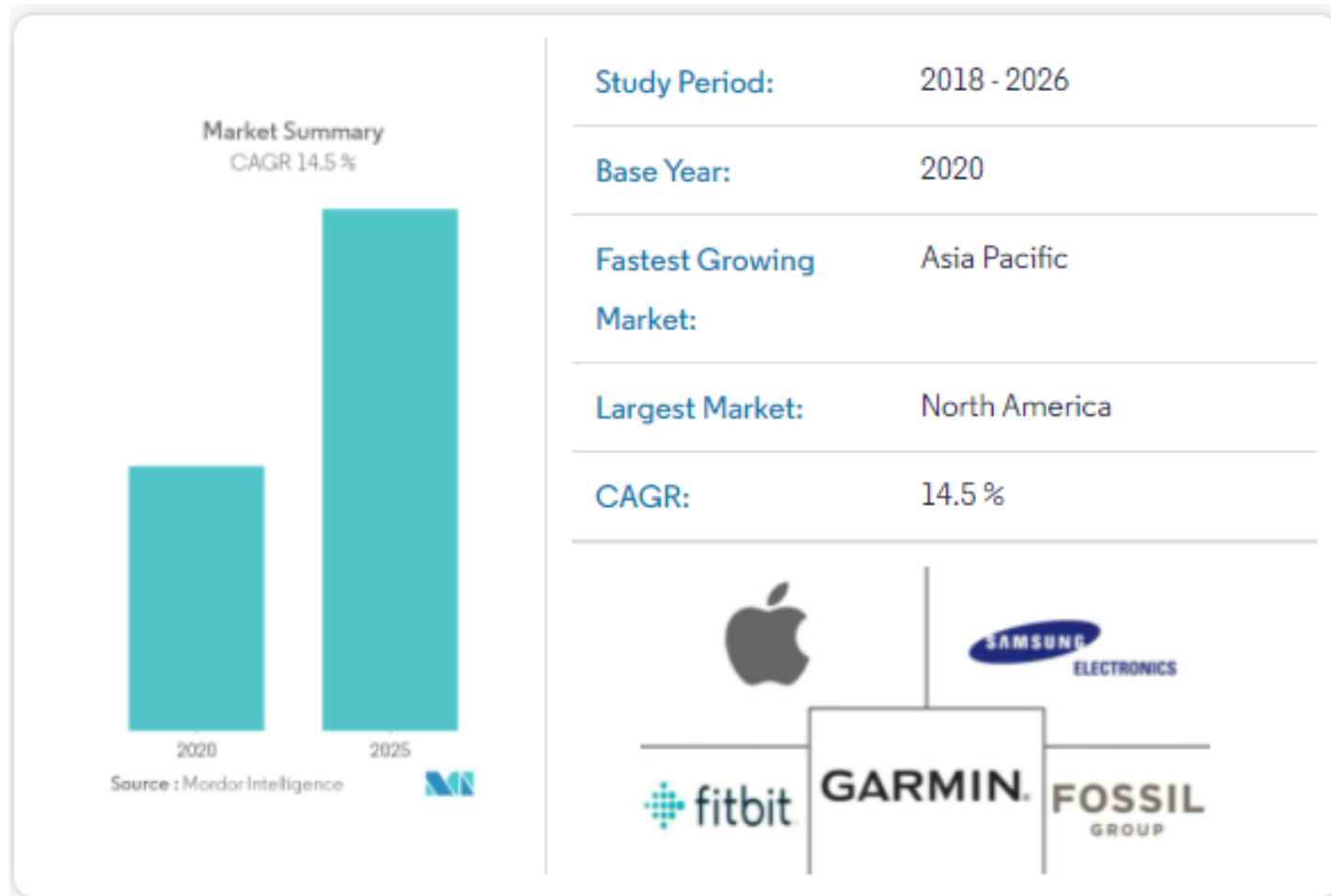
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BI INTELLIGENCE

Trends in Mobile: Smart watches



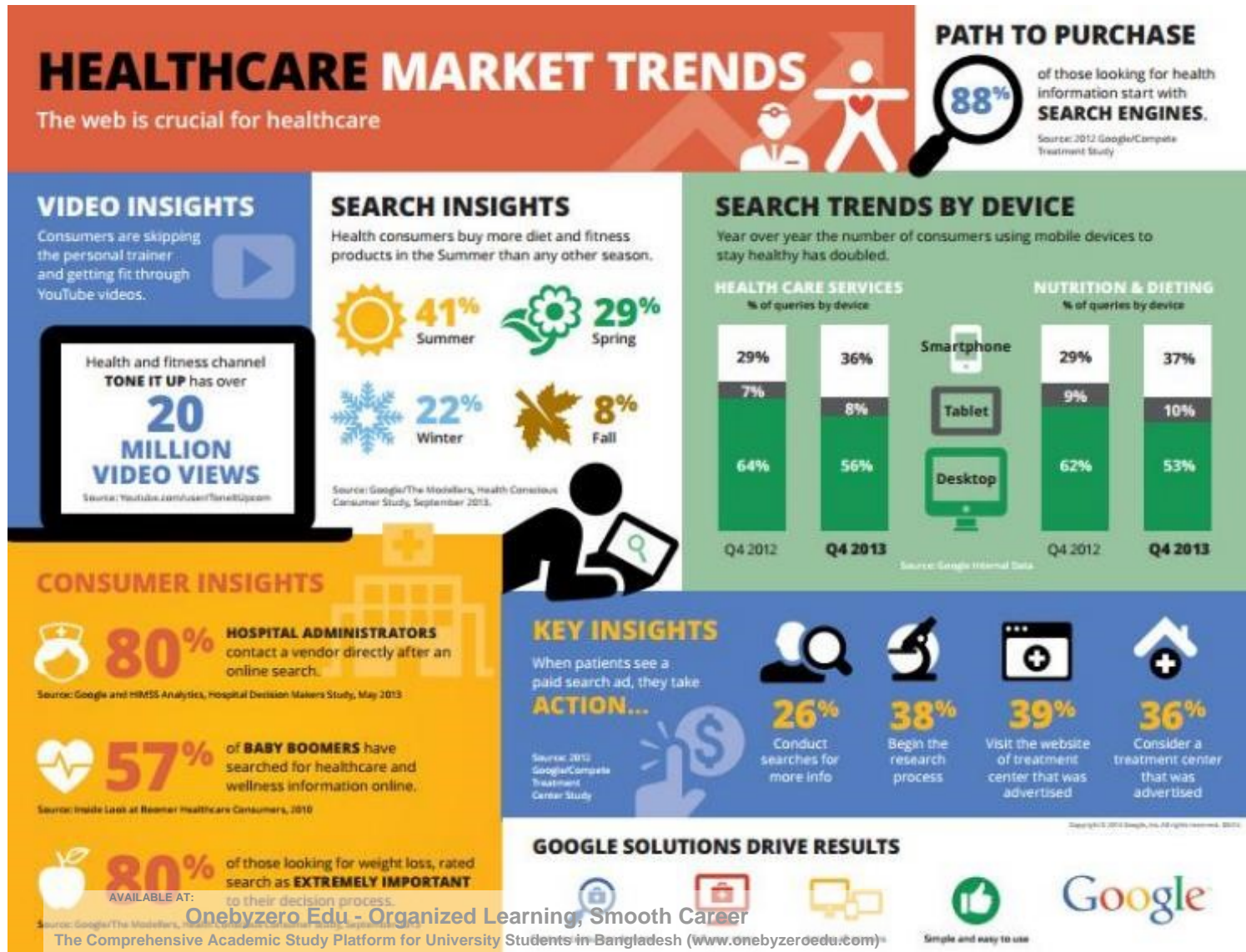
Smartwatch Market Size



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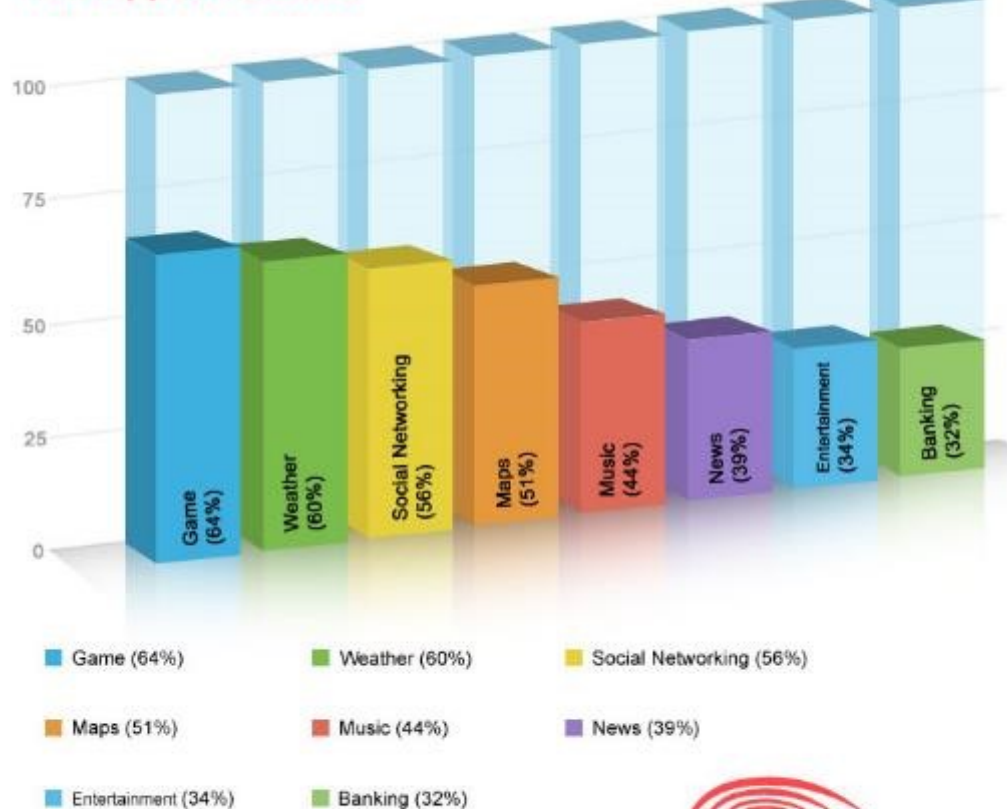
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Trends in Mobile: Healthcare



Trends in Mobile: Apps

How Apps Are Used



Source: Nielsen

Website: www.crispycodes.com | Email: info@crispycodes.com

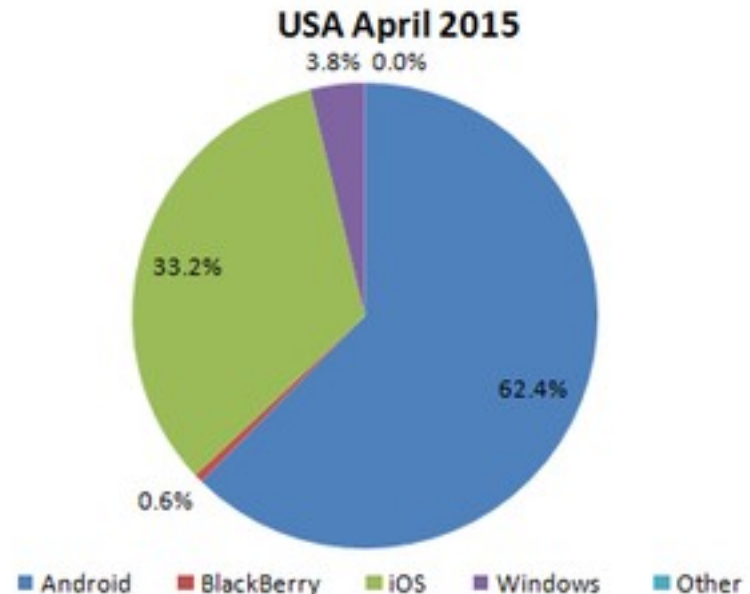
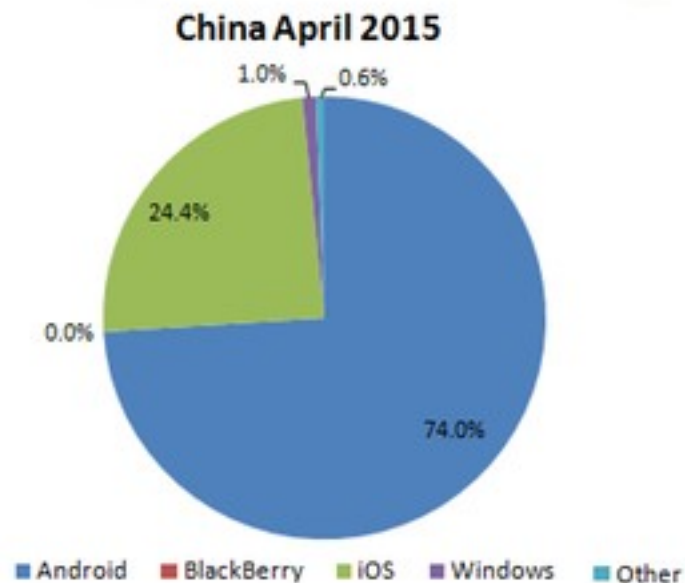
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Trends in Mobile: Smartphone OS

Smartphone Operating System Market Share



Market Realist[®]

Source: Kantar World Panel

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Trends in Mobile: Apps



iOS App Statistics

In addition to announcing iOS 9, the newest OS X, and a new streaming music service at their annual developer conference WWDC, Apple this week announced some pretty staggering statistics from the App Store. Here's a summary:



100
billion

apps downloaded
since 2008



1.5
million

apps in the
App Store



119

apps downloaded
per iOS user



850

apps downloaded
per second

Trends in Mobile: Students



**NEARLY ALL STUDENTS
TEXT EVERYDAY...**

Send texts everyday

YES 94% **NO 06%**



**...MUCH MORE THAN
MAKE CALLS EVERYDAY.**

Make calls everyday

YES 73% **NO 27%**



**TECH ADDICTION? MANY
STUDENTS EXPERIENCE IT.**

Sometimes feel 'addicted'
to phone

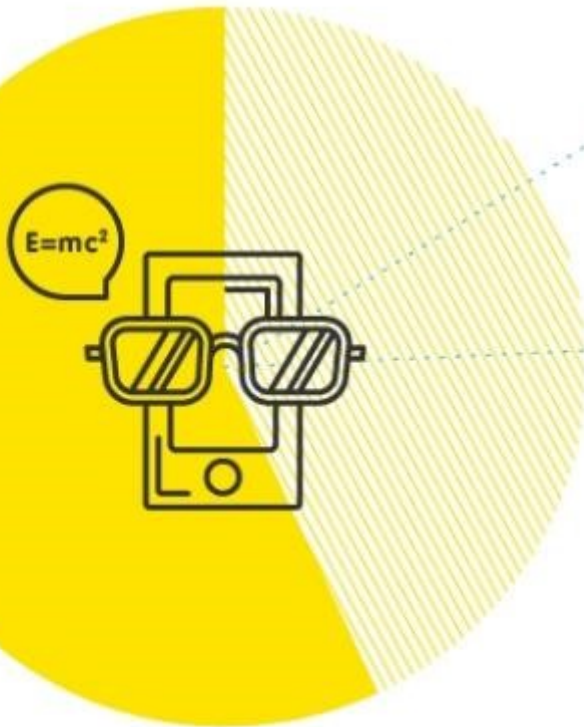
YES 60% **NO 40%**

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Trends in Mobile: Students



IPHONE AND ANDROID ARE NECK-AND-NECK FOR THE TOP SPOT

IPHONE	42%
ANDROID	43%
BLACKBERRY	12%
WINDOWS 7	02%

NEARLY ALL SMARTPHONE OWNERS USE THEM FOR SOCIAL NETWORKING...

Use phone for social networking

YES 97% NO 03%



BUT LUCKILY, CHEATING ON A PHONE IS RARE

Has cheated on test with phone

YES 13% NO 87%

A MAJORITY OF STUDENTS IN OUR SURVEY USE SMARTPHONES.

SMARTPHONE: 57% BASIC: 43%

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